The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

BOUVERIE HOUSE, 154, FLEET STREET, LONDON, E.C.4

Telegrams: ALLANGAS FLEET LONDON — Telephone: CENTRAL 3212 (10 lines)
GLASGOW: 116, Hope Street (Central 3970) — BIRMINGHAM: Daimler House, Paradise Street (Midland 0784-5)
THE CHEMICAL AGE offices are closed on Saturdays in accordance with the adoption of the five-day week by Benn Brothers, Limited

VOL. XLV. No. 1149 — July 5, 1941 — Annual Subscription, 21s. Overseas, 26s.

Caustic Embrittlement

STEEL is the principal metal used in the construction of pressure vessels and a knowledge of the factors that are likely to cause failure in these vessels is of particular interest to the chemical engineer. A steam boiler is a pressure vessel that in theory contains only water in two phases, but in practice may contain a number of organic and inorganic chemical substances that through the conversion of water into steam may in the boiler, and particularly locally, reach a high concentration. Although the subject of caustic embrittlement is primarily investigated from the work of steam-boiler practice, the work done thereon has a wider interest to all chemical engineers who are called upon to design pressure vessels. This subject has been under investigation for nearly 30 years and the latest contribution to knowledge is a paper on "Intercrystalline Cracking in Boiler Plates" contributed by the National Physical Laboratory under the general direction of Dr. Desch, which is summarised in our Metallurgical Section this week.

Caustic embrittlement is a misleading title, which is better replaced by "caustic cracking" because after failure, the steel between the cracks may retain its normal characteristics. This type of metal failure is characterised by the path of the cracks, which pass between the crystals and not through the crystals. It is most common at riveted joints and often extends along a joint through a number of rivets, but it is not found in seamless or welded vessels except occasionally around fittings. Certain other forms of intercrystalline cracking familiar to the chemical industry are evidently related to this type of boiler cracking. Steel vessels in which solutions of caustic soda are concentrated under atmospheric pressure frequently crack, especially at riveted joints, and the cracking of pans containing solutions of nitrates, especially ammonium nitrate, is well known. In both cases the cracks pass between the crystal grains.

Serious power-station and other boiler accidents have come about through intercrystalline cracking and these have always occurred when the water used in the boiler has received alkaline treatment. The explanation which has hitherto held the field and which has been confirmed and extended by the work of the N.P.L., is due to Parr and Straub of the University of Illinois and is based on the fact that sodium hydroxide reacts with iron, liberating hydrogen. This reaction appears to take place to an appreciable extent only when the concentration of caustic soda is over 30 per cent., a figure which is unknown in the interior of a boiler. Parr and Straub, noting that the usual site of the cracks is where butt straps are attached to the shell by rivets, presumed that there might at this point be a seepage of the boiler water between the plates and the strap, and also around the rivets; this water would be continuously evaporated and replaced, so that a high local concentration of alkali could occur, leading to the generation of hydrogen. It was also established that the steel must be in a highly stressed condition for damage to occur, but stress alone is insufficient unless the chemical reagent also is present. Cracking, of course, may be produced by mechanically defective metal in the absence of alkali, but the cracks are not then intercrystalline.

German workers, ignoring Parr and Straub's results, endeavoured unsuccessfully to blame the quality of the metal. Another school of thought has maintained that sodium silicate is responsible and not sodium hydroxide. The N.P.L. have shown that sodium silicate can under certain circumstances decrease the time elapsing before failure occurs, but their experiments show clearly that caustic soda unaccompanied by sodium silicate will cause intercrystalline cracking. American investigations have shown that the action of alkalies may be retarded or accelerated by the presence of other salts and that some salts may act as accelerators under one set of conditions and as retarders under another, so that the factors are evidently complex.

Earlier experiments at the N.P.L. have shown that in the absence of chemical attack intercrystalline failure will not occur at 300° C. as the result of stress alone. In general the higher the temperature the more likely is this type of failure; it does not seem to occur at temperatures, say, below 100° C., and from 250° C. upwards appears to be the temperature range at which it is most active. Repeated bending of the metal does not produce this type of cracking nor is it due to corrosion fatigue. In the light of these negative results the N.P.L. started an extensive investigation into the mechanism of intercrystalline cracking of steel and this work so far as it has gone is summarised later in this issue. It will be seen that hydrogen liberated by the chemical reaction penetrates the steel and reacts with the carbon therein, forming methane, which accumulates until a high pressure is reached. Two distinct forms of cracking, however, the hydrogen type and the oxygen type, have been discovered. In the latter type methane is not formed and the oxide apparently seals the crevices, allowing a high pressure to develop. Altogether the N.P.L. is to be congratulated upon an excellent and widely interesting piece of work.

CONTENTS

NOTES AND COMMENTS

Preserving Vital Papers

IT is of especial interest at this juncture to hear of the work of the U.S. National Bureau of Standards in the lamination of paper with cellulose acetate sheeting. Throughout our cities masses of documents might have been saved; we do not refer, of course, to those which have been blown to smithereens or burnt, but to all that were ruined by dust, heat, water, and the rough usage resulting from air-raid damage, when a tougher paper would almost certainly have escaped harm. Six firms and the National Archives of the United States were, it is reported, provided with identical samples of paper of the type generally used for documents; the papers were laminated with acetate sheeting, returned to the Bureau together with the types of sheeting employed, and tested. In three instances the sheeting was applied with heat and pressure alone; in a fourth case it was similarly applied, but the sheeting contained an adhesive as well The remainder made use of adhesives, although the laminated sheets were applied to the paper by pressure only. The result of all the tests was satisfactory. The sheetings were examined for certain chemical and physical qualities in addition to stability and resistance to wear. Their strength, it was found, reached the high level of that of the best-grade papers made for permanent records. The laminæ were effectively applied, the permanence of the bonds being tested by subjecting them to extreme changes in moisture content as well as baking at high temperatures. Many of the samples remained unaffected when heated for 72 hours at 100° C., though some turned yellow. Other desirable qualities of the acetate sheeting, besides its strength and stability, are thinness, transparency, and resistance to insects. Moreover, it is easily cleaned with water.

Indian Mineral Resources

SIR LEWIS LEIGH FERMOR has given a survey of India's mineral resources in the *Asiatic Review*, in which he shows how the mineral industries have expanded since the last war and how they may be of increased assistance in the present conflict. India's most important minerals for war purposes are coal, manganese-ore, mica, iron ore, copper ore, chromite, and bauxite: in all these, except copper ore, India can make a substantial contribution to the common effort. Apart from the manufacture of pig iron and steel in the country, large quantities of high-grade iron ore could easily be exported, while the exports of pig iron to Britain could also be increased. Sir Lewis observes that the bauxite deposits are of considerable extent and high quality and the supply of cheap electric power for its conversion into aluminium should be made readily and easily available near the deposits in Bihar, Orissa, Central Provinces, and Bombay. The total average annual value of the war minerals has increased from £9,677,647 in 1914-1918 to £12,807,611 in 1934-38, whilst the total value of all minerals has increased from £9,860,185 to £13,609,844 in the same periods. Comparing the production of the two periods, with the exception of gold, saltpetre, tungsten-ore and corundum, increases are shown by every mineral. Specially noteworthy are the increases in the output of petroleum from 7.3 million gallons to an average of 74 million gallons; mica, from 50,000 cwt. to 177,000 cwt.; copper-ore from 8,000 to 339,000 tons; iron ore from 400,000 to nearly 2½ million tons, mainly to meet the needs of Indian manufacturers of pig iron and steel; finally, the substantial increases in the output of chromite, refractories, magnesite, and bauxite. The increase in the production of coal from 18 to 24 million tons, though less than had in some quarters been predicted, is yet substantial, and is a good indication of the expansion of industry especially of the iron and steel industry with its large consumption of coke.

Butadiene Inflammability

THE explosive hazard of butadiene, a combustible gas which is finding importance in to-day's national defence programmes, is pointed out in a report recently submitted to the U.S. Secretary of the Interior by Dr. R. R. Sayers, Director of the Bureau of Mines. Calling attention to the possibility of explosions in industrial establishments from the use of combustible organic chemicals which a few years ago were laboratory curiosities, but to-day are manufactured in large quantities, the report declares that this danger is inherent in such substances as butadiene, which is used, *e.g.*, in one of the processes for manufacturing synthetic rubber. To provide industry with a key to the explosibility of butadiene, the Bureau of Mines conducted a number of tests to determine the limits of inflammability of the gas. The Bureau's report shows that this substance will explode when as little as 2 per cent. is present in a mixture with air. The experiments were so conducted that the results would be applicable to industrial conditions where large volumes of butadiene-air mixtures are involved. Tests revealed that when the gas is properly mixed with air, at ordinary room temperatures and pressure, it will propagate a flame if the percentage of butadiene is anywhere from 2 to 11.5 per cent. by volume. The studies were undertaken in accordance with the Bureau's programme of promoting safety in the mining and metallurgical industries, one phase of which is the determination of the hazards involved in the use of combustible materials and the investigation of means of mitigating and preventing explosions.

Chemicals in Japan

THE total value of imports of chemicals, drugs, medicines, and explosives into Japan during the first nine months of 1940 was 172,473,275 yen compared with 126,289,655 yen in the same period of the previous year. This is an increase of 36.6 per cent. Gum and gum resins were the most important commodities imported in the group, the purchases for the period under review being 889,585 cwt. valued at 53,974,299 yen, though the figures for the corresponding time in 1939 were 1,187,468 cwt. at 43,121,108 yen, a decrease of 25.1 per cent. in quantity, but an increase of 25.1 per cent. in value. Sulphate of ammonia was imported to the extent of 117,893 metric tons valued at 18,162,955 yen (67,169 metric tons and 6,659,993 yen), a substantial increase in both volume and value. Soda ash accounted for 1,896,961 yen. Other drugs, chemicals, medicines, explosives and compounds thereof were imported to the value of 98,439,060 yen compared with 75,192,502 yen, and consisted largely of potassium chloride, sulphate, and nitrate.

Sodium Sulphate Production*

The Submerged Combustion Method of Dehydration

REASONS for many of the difficulties encountered in dehydrating Glauber's salt are disclosed by the water-solubility curve of sodium sulphate. The solubility increases with the temperature as long as the stable solid phase is the decahydrate, $Na_2SO_4.10H_2O$, but at 33° C. the anhydrous salt becomes the stable one and continues as such to the boiling point. Beyond 33° solubility of the anhydrous salt decreases, quickly at first and then slowly. This inverted solubility characteristic means that from a saturated solution undergoing evaporation, the anhydrous salt forms a heavy scale rapidly on the heating surfaces of the equipment. To cope with this tenacious scaling characteristic many procedures have been proposed and practised.

In the field of evaporators, equipment with a number of steam chests employed in rotation has been used; one chest is de-scaled while the others are in service. In this field also, forced or rapid-circulation evaporators in which high velocities through the tubes and small temperature changes are maintained have been operated. To reduce this scaling in evaporators, a procedure sometimes followed is to operate at temperatures at which the saturation curve is relatively flat; the reason given is that the decrease in solubility for a given temperature increase is small and hence scaling should be less pronounced.

Rotating steam drums have been employed in the evaporation of sodium sulphate solutions. The drums, partly submerged in the liquid, are heated internally with the steam under pressure. As the drums rotate, the coating of sodium sulphate picked up during submergence is scraped off by properly placed knives. The great objection to this procedure is the large amount of evaporating surface required per unit of production; the tenacious adherence of the sodium sulphate to the drum surface is a major obstacle to satisfactory functioning of equipment.

The Sodium Chloride Method

An apparently satisfactory method, where common salt is available at exceptionally low cost, is to precipitate the sodium sulphate from solution through preferential dissolving of sodium chloride. The sodium sulphate is thrown down as the anhydrous salt from its hot solution through the addition of the sodium chloride.

Another procedure for converting the decahydrate to the anhydrous form is to melt it in a stream of hot sodium sulphate slurry, to separate the anhydrous salt by filtration and to return the saturated filtrate to the top of a tall tower, down which it showers and meets ascending hot gases which accomplish evaporation. The slurry from the bottom of the tower retraces its cycle. This method has been practised in South America.

Large direct-fired rotary dryers have been used for dehydrating Glauber's salt, particularly at locations where the salt has been stock-piled and partially air-dried. All these methods with the possible exception of the one involving the use of common salt have to contend in varying degree with scaling problems.

In 1933 the Ozark Chemical Co. built a sodium sulphate plant beside a so-called "alkali" lake 13 miles south of Monahans, Texas. At the outset rotating steam drums were operated, but these were soon abandoned because of low capacity and of difficulty with scale adhering tightly to drum surfaces. Dehydration in direct-fired unlined steel rotary-kiln equipment was next practised for about 18 months. The Glauber's salt, coming as a snow-like material from the filter in the refrigerating department and containing a total of 60 to 62 per cent. moisture (56 per cent. represented water of crystallisation), was charged directly to the rotary dryer. Almost immediately the material melted to make a thin slurry, about 15 per cent. solids and 85 per cent. saturated solution or actually about 1.5 lb. water per lb. of solids. Skilled operating technique and intense firing were required to produce a dried material containing less than 0.1 per cent. moisture. Low fuel efficiency and high maintenance costs on equipment, together with a never-ending struggle against scale, particularly on the inside of the shell of the rotary kiln, were factors prodding the search for an improved method.

Submerged combustion at length proved to be a satisfactory answer. Theoretical considerations made this method appear well suited to the task of dehydrating Glauber's salt. Some statements on submerged combustion have appeared in technical literature for 50 years or more, but no commercial equipment for evaporating large quantities of water by such means was known in 1934. Considerable research and development on all parts of the equipment involved had to be done, but in November, 1935, the first commercial unit was installed and has operated practically continuously since that date.

The Submerged Burner

The submerged burner may be first lighted and suspended above a combustion tank, and then lowered into the sodium sulphate solution. However, the usual operating practice is to light it when submerged by means of an igniter. Hence, ordinarily, a burner is raised from its tank only for repair or replacement purposes. The submerged burner developed for the evaporation of sodium sulphate solutions differs in several respects from previously suggested burners of this type. Utmost simplicity was the keynote in its development and the result was that its final construction was surprisingly simple. To arrive at this result a number of previously accepted ideas regarding submerged combustion had to be discarded, such as use of ceramic lining and of flash-back grids and constriction of burner discharge opening.

Submerged burners possessing a ceramic or refractory lining to facilitate and complete the combustion of the fuel have been proposed and developed by some workers in this field. When combustion occurs in a small space and at velocities approaching that of flame propagation, maintenance of a flame front that will burn continuously is often difficult to accomplish. To assist in maintaining combustion and, incidentally, to prevent flash-backs, some have used a finely perforated grid in the throat of the burner. This, of course, complicates the construction and limits the flexibility as related to capacity. Proper design of the shape of the throat of the burner resulted in abandoning the use of both the ceramic lining and of the grid work. A properly dimensioned expansion chamber (the zone between the intake and the combustion part of the burner) permits the maintenance of a continuously functioning flame with a considerable variation in the amount of fuel burned. That cold metal functions satisfactorily as a burner surface has been proved. Also when theoretically sufficient air for complete burning is mixed properly with the gas before introduction into the combustion zone the combustion is as thorough as ever occurs in a high-temperature, refractory-lined firebox.

In most submerged burners described the outlet for the products of combustion has been reduced or constricted in size as compared to the cross-sectional area of the combustion zone. As advantages of this, better propagation and continuity of flame have been claimed. These gains may have some dubious value in evaporating solutions having slight or no scaling characteristics, but in the treatment of sodium sulphate solutions the tendency of the salt deposited on the burner to bridge over and close the burner discharge outweighs these considerations. When this undesirable process is occurring, the velocity of discharge of the burned

* From a paper by E. W. Douglass and C. O. Anderson, Ozark Chemical Co., in *Chem. Met. Eng.*, 1941, *48*, 5, p. 135.

gases increases and sets up unfavourable back pressures, but in spite of this the flame is soon smothered.

By eliminating any reduction in size of the burner outlet, that is, by maintaining the same cross-sectional area at the discharge as in the combustion zone, the described bridging by the deposited salt is overcome. To assist in this, the burner is operated at near its maximum burning capacity so that satisfactory velocities may be maintained. Furthermore, the tendency to bridge is less as the diameter of the burner increases. Successful performance is achieved in these troublesome solutions with burners 6 in. and upwards in diameter.

The Life of a Burner

Most of the heat energy released by the burner is discharged with the products of combustion into the solution, but some of it is transferred through the metal wall. Intense temperatures within the burner, 1300°-1500° C., and a temperature of about 87° C. in the solution in contact with the outside of the burner, represent a condition under which some sodium sulphate is precipitated as a scale on the surface of the burner. This scale insulates the metal, with the result that its temperature rises rapidly; however, the scale pops off from time to time and takes with it thin layers of metal. This metal loss is greater near the burner discharge than elsewhere. The life of a burner made of common steel is equivalent to the production of about 500 tons of sodium sulphate. Burners of many different alloy compositions have been used, but none to date has justified its cost in comparison with that of common steel. The iron content of the finished sodium sulphate is of the order of 0.01 per cent Fe, often very much less, hence the amount contributed by the burner is nearly negligible.

The submerged combustion tank in which the submerged burner operates is small, about 8 ft. diameter and 12 ft. overall height. During evaporation a high degree of supersaturation of the solution develops and intense scaling of the tank surfaces would be the result if it were not for the violent agitation and special features of design and materials, developed over a long period of testing and research. The burner in operation is suspended deep in the conical section of the submerged combustion tank and is supplied its properly proportioned natural-gas-air mixture through a large hose. The combustion gases and water vapours pass up the tank stack to the atmosphere. The sodium sulphate slurry is drawn off continuously from the bottom of the tank by means of a pump and is sent by pipe line to the settling tank. A duplicate pump on the opposite side of the submerged combustion tank is in reserve to eliminate interruptions to the operation.

The density of the sodium sulphate slurry withdrawn from the burner tank is low, only about 5 per cent. solids. The cone-bottomed settling tank (5 ft. dia. × 10 ft. high) yields a practically clear overflow, part of which is returned directly to the burner tank and part of which is employed to melt the Glauber's salt from the filter in the chilling department, and is then returned to the burner tank. The settling tank underflow is controlled by a rotating star valve to deliver a dense slurry containing up to 70 per cent. Na_2SO_4. A splitter-box below the star valve permits dividing the discharge between a continuous centrifuge circuit and a 60-ft. rotary dryer (7 ft. dia.) circuit.

High-Purity Product

The centrifuge reduces the moisture to between 5 and 6 per cent. The centrifuge filtrate is returned to the burner tank or the large rotary dryer and the dewatered cake is dried in a small rotary dryer (3 × 25 ft.) to a very high quality grade of anhydrous sodium sulphate with a purity of 99.9 + per cent. Na_2SO_4. The dense slurry passing to the large rotary dryer is dried to a somewhat lesser quality product and is marketed as glassmakers' and papermakers' salt cake with a purity of 99.3 per cent. Na_2SO_4.

Since submerged combustion has been in use in the Monahans plant, about 115,000 tons of sodium sulphate have been made in the described circuits.

The most important advantages resulting from the use of submerged combustion have been in combating successfully the scaling tendency of sodium sulphate solutions by not having to transfer heat through metal walls, and in securing high thermal efficiency—approximately 90 per cent. of the net B.Th.U. value of the natural gas is applied directly to the heating and evaporating tasks. Lesser advantages are moderate first cost, continuity of operation, low operating temperatures, low labour cost, and flexible circuits permitting manufacture of quality products.

Movement of U.S. Chemical Trade

Exports Generally Higher

EXPORTS of chemicals and allied products from the United States during the first quarter of 1941 continued the expansion evident in the last year and a half, according to statistics published in *Foreign Commerce Weekly*. A total of $65,200,000 was attained, compared with $61,200,000 the first quarter of 1940. Large increases were recorded in shipments of explosives—from a value of $1,600,000 in the first three months of 1940 to $4,500,000 during the same period of 1941. Exports of fertilisers and fertiliser materials increased from $3,300,000 to $4,000,000 during the period; industrial chemicals rose from $13,400,000 to $14,900,000; essential oils, from $900,000 to $1,500,000; and medicinal and pharmaceutical preparations from $7,200,000 to $9,100,000. Some of these value increases were attributable to higher prices, as in the case of essential oils, quantity exports of which advanced only 5 per cent. from 597,000 to 628,000 pounds, although the value was up nearly 60 per cent.

Little change was noted in the total values of coal-tar products ($7,855,000 in the first three months of 1940 and $7,936,000 in the 1941 period), in soap (from $870,000 to $815,000), and toilet preparations ($1,576,000 and $1,575,000). Exports of pigments, paints, and varnishes declined from $7,055,000 in the first quarter of 1940 to $5,538,000 in the first quarter of 1941, and of chemical specialties from $9,987,000 to $9,403,000.

United States import trade in chemicals and allied products was characterised generally by smaller receipts of the majority of items making up the total of $32,715,000, a decline of 20 per cent. from the corresponding quarter of 1940. Higher prices were evident in many lines.

Outstanding exceptions to the general trend were appreciable gains in imports of certain raw materials. Among these commodities were: cod-liver oil from Iceland and Japan, gums from the Far Eastern countries; cinchona bark and quinine sulphate from Netherlands East Indies; citronella and lemongrass oils likewise from the Far East as well as Latin America (Guatemala); sandalwood oil from India; lime oil from the West Indies and Mexico; acetic acid from Canada, Mexico and Japan; crude glycerine from Latin America and the Philippines; iodine from Chile; sodium cyanide and cyanamide from Canada; and common soap from Argentina and the Philippines. A substantial quantity of lavender oil was received from France during the quarter.

EXTRACTION OF GLUTATHIONE FROM YEAST

Yeast is known to contain glutathione, but existing methods of extraction are not very satisfactory. A new process of the Schering Company (D.R.P. 694,546) involves preliminary treatment with a salt of the type of gypsum. In an example, 20 kg. pressed yeast are intimately mixed with 22 kg. gypsum, and the resulting slurry is dried in a thin layer at room temperature for 24 hours. Repeated extraction with water at 60°-70° C. yields an aqueous extract of 50-60 litres which contains 71 gm. glutathione. The latter is isolated by adding 5050 c.c. 15 per cent. lead acetate solution, which is followed immediately afterwards (without filtering) by 14,500 c.c. 10 per cent. mercuric acetate solution. The precipitate is then filtered, decomposed with hydrogen sulphide, and the glutathione recovered from the resulting filtrate as the copper salt by treatment with copper oxide.

LETTER TO THE EDITOR

Fire-Fighting Chemicals

SIR,—Our attention has been drawn to the Editorial in the June 21 issue of your journal, and we should like to make a few comments on the obviously sensible statements contained therein.

This company has for a number of years specialised in the extinction of fires in light metals in which category we include magnesium, magnesium alloys, "elektron," aluminium, and sodium. Most of these metals are very difficult to ignite except in a finely divided form, but once ignition has occurred all known methods and media of extinction are useless. Water, carbon dioxide, mechanical or chemical foam and all materials with an aqueous base as well as chlorinated hydrocarbons (CCl_4) only serve to increase the intensity of the combustion. It is, of course, based upon these facts that magnesium or magnesium alloys are used for the metal casings of incendiary bombs.

After a considerable amount of research and experiment, we succeeded in producing a dry powder known as "DX" Powder for extinguishing fires occurring in light metals during the process of machining or grinding. The extinction is generally so rapid and complete that in the majority of cases unburnt metal can be recovered.

From the foregoing you will realise that it was perfectly natural for us to turn our attention to the extinguishing of magnesium incendiary bombs by using our "DX" Powder. In this we have been completely successful even in cases where genuine magnesium incendiary bombs have been ignited on wooden flooring. Naturally, a certain technique of application of the extinguishing powder had to be developed, but the same provision applies to the use of the stirrup pump or any other extinguishers used on incendiary bombs.

Official tests *carried out by us* for Government authorities have resulted in complete success in this respect, but when such tests have been conducted by certain Government authorities at which no members of this company were present, the report has always been that the stirrup-pump or sand-container technique, as evolved by the Ministry of Home Security, was to be preferred. From your reference to the doubt in the minds of the Ministry as to how water should be used, we assume that you have been informed of the treatment accorded to the manufacturers of "Kwench" (Fleetwood Chemical Co., Ltd., London, S.E.8), and in this connection we would refer you to our article "Extinguishing Magnesium Fires" (*Light Metals,* June 1941), in which the question of correct official tests and the requisite knowledge for conducting them is referred to.

We should like to say that your Editorial is the first one that we have seen which contains the very obvious truth that each fire should be dealt with on its own merits. This is, of course, a world-recognised fact to all fire engineers, or, in other words, it is well known that no two fires are alike and that therefore no hard and fast rule can be laid down as to which type of apparatus and method of extinguishing is suitable for any one particular fire. This, in our opinion, is where the Ministry of Home Security have slipped up, and in general we cannot see how the insistence that water used through a stirrup pump is suitable for incendiary bombs can be maintained, unless the class of bomb is specified. One of the first requirements of any fire appliance is that it should be incapable of wrong use (i.e., foolproof). Water used through a stirrup pump can easily be wrongly used—spray instead of jet or *vice versa*—even by experts. It is impossible, therefore, to agree with you that water "is certainly the safest for the inexpert private citizen to use." We have no guarantee that the enemy will not suddenly use sodium bombs, and the result if the stirrup pump with water, either jet or spray, was used would not be exactly encouraging except to the enemy!

The Ministry of Home Security when caught say they prefer to extinguish the resultant fire. This is just because they cannot extinguish a magnesium incendiary bomb with water and so they, in effect, suit the fire to their approved appliance.

The oil bomb itself, once it has operated, does not present any particular difficulty except that it really constitutes an oil-saturated surface fire, in which case the ordinary smothering agents such as foam, methyl bromide, soda acid where wood is involved, or CO_2, are perfectly suitable. In connection with the oil bomb, however, we would ask you to consider the problem of the self-igniting liquid if this should be used.—Yours faithfully,

for Durston, Lang & Co., Ltd.,
G. HAROLD DURSTON,
Technical Director.

Harrow Weald, Middlesex.
June 26, 1941.

New Export Facility

Destination Control Certificates

THE Ministry of Economic Warfare announces that a new facility has been provided for exporters in the United Kingdom, in the form of a document called a Destination Control Certificate. Goods exported from this country are sometimes transhipped or unloaded at ports in other parts of the British Empire, in Egypt, Portugal or the Persian Gulf *en route* for the neutral destination for which the export from the United Kingdom was duly permitted by H.M. Customs. In order to avoid any unnecessary delays in granting at such ports transit facilities for these goods, it is desirable that an official document, showing the ultimate destination of each consignment, should accompany the goods for presentation to the authorities in the port of discharge.

Such a document, known as a "Destination Control Certificate," can now be obtained for these goods, on application to H.M. Customs in a United Kingdom port, and exporters are advised to ask for this certificate whenever it would appear necessary.

British Chemical Prices

Market Reports

VERY firm price conditions prevail in the general chemicals market, and traders report a fair volume of new inquiry both for home and export account. Contract deliveries are reported to be fully maintained, and the supply position on the whole continues steady except in one or two directions where offers are considerably below the demand. An active inquiry is reported for both the B.P. and commercial grades of permanganate of potash and elsewhere in this section supplies of caustic, bichromate and yellow prussiate of potash are quickly absorbed for priority needs. In regard to the soda products, there is a steady flow of trade in most items, with quotations unchanged. Market activity in the coal tar product section is fairly brisk, and there is a good call for creosote, carbolic acid and cresylic acid, the last named item enjoying a fairly active export inquiry.

MANCHESTER.—So far as new business is concerned, reasonably active trading conditions have been reported on the Manchester chemical market during the past week. Chemicals for textile bleaching, dyeing, and finishing have continued in fair demand, and a good call for contract supplies has been reported in other directions, particularly for the leading heavy products, including the alkalies. Values are steady to firm throughout the range. With an odd exception, the tar products are being taken up in good quantities against contracts, and sellers report no lack of fresh inquiry. By-product prices generally are on a very strong basis.

GLASGOW.—Business in the Scottish heavy chemical trade has shown a slight improvement, both for home and export trade, during the past week. Prices keep extremely firm with a tendency to rise.

Price Changes

Ammonium Sulphate.—Per ton in 6-ton lots, d/d farmer's nearest station: July delivery, £9 10s. Increase of 1s. 6d. per ton for every month up to £10 0s. 6d. in February, 1942; March/June, 1942, £10 2s.

Cresylic Acid.—MANCHESTER: Pale, 99/100%, 3s. 3d. per gal.

Lactic Acid.—Dark tech., 50% by vol., £37 10s. per ton; 80% by weight, £79; pale tech., 50% by vol., £44 per ton; 80% by weight, £86. Not less than one-ton lots ex works; barrels returnable; carriage paid.

Pyridine.—MANCHESTER: 14s. to 18s. per gal.

A CHEMIST'S BOOKSHELF

NUMERICAL AND CONSTITUTIONAL EXERCISES IN ORGANIC CHEMISTRY. By J. L. B. Smith, M.Sc., Ph.D., F.R.S. (S. A.), and M. Rindl, D.Ing., F.R.S. (S.A.). London: Methuen. Pp. 213. 7s. 6d.

Most students of organic chemistry must have felt at one time or another that there existed a gap between the text-books on the subject, excellent though they are, and the application of the knowledge therein gathered to the difficult subject of deciding the constitution of an unknown substance. There are, of course, a number of reactions which are learnt through the medium of established text-books and which when applied experimentally enable a simple body to be put into its class. Once that has been done the determination of the physical characteristics of a pure substance is usually sufficient to identify it positively. The knowledge of how to do this and the opportunity to obtain practice in doing this are, however, gained only with difficulty, and the solution of problems in the constitution of organic bodies demands and develops powers of deduction and critical interpretation which come only with experience. At this stage in the world's history it is difficult to write a new text-book, but the authors of this volume appear to have done so. We do not recollect having come across any similar book, and the authors are entitled to claim that this is the first comprehensive work dealing with the *solution of problems* in organic chemistry. It is said to be written in a style suitable for a beginner; that may be true, in a sense, but a beginner will find it necessary to read this book only chapter by chapter as he is reading parallel chapters in the usual text-books on organic chemistry.

The book is divided into 18 chapters, most of which deal with a particular class of body or structure, such as alcohols and ethers, amines, unsaturation, isomerism, ketones, orientation, and so forth. In a few pages at the beginning of each chapter are given the basic facts and reactions utilised in determining the structure of bodies of that group. This is followed by a problem and its solution, and this again is followed by a number of problems for the student to work out. It is suggested that once the student has worked out a problem he will inevitably know whether he has found the correct solution or not, since everything will fit into its place. It is further suggested that no student should be satisfied until he has solved each problem by his unaided efforts. Nevertheless, the authors have recognised the frailty of human nature (and of student human nature in particular) and have given at the end of their book a detailed solution of every problem. In our opinion this book (for once) really fills a gap. It will be of great help to teachers of organic chemistry and to students who are working largely alone. It will, in fact, also be of value to every student, but in our opinion its value will be greatest in the later and more knowledgeable stages of his studies of organic chemistry, because there is not enough in each chapter to constitute a text book in itself.

CHEMICAL DICTIONARY. Ed. by F. H. Campbell, D.Sc., F.A.C.I. Melbourne and Sydney: Tait Publishing Co. Pp. 83. 5s. 6d.

The utility of this little book is awkwardly disguised by its title, which creates quite a wrong impression. Dr. Campbell has not compiled a chemical dictionary, but a list of definitions for chemists of chemical and other scientific terms. The idea is extremely good, the book is of handy size, and the definitions in the main are extremely helpful towards the understanding of unfamiliar branches of chemical science. But it is essential that the proof-reading in a work of this kind is flawless, otherwise it cannot help but be misleading; and there are numerous minor flaws to be eliminated in a next edition.

Personal Notes

DR. J. C. SWALLOW, M.I.Chem.E., has been appointed Director of Research by I.C.I., Ltd., at Winnington.

MR. W. JORDAN ADAM, M.I.Chem.E., has been appointed a member of the Chemistry Research Board of the Department of Scientific and Industrial Research.

DR. A. J. V. UNDERWOOD, M.I.Chem.E., has been elected Deputy-Chairman for 1941-42 of the Joint Committee on Materials and their Testing.

MR. W. H. STEVENS, A.R.C.S., F.I.C., has recently joined the staff of Monsanto Chemicals, Ltd., and is now on his way to the U.S.A.

MR. W. O. QUINLAN, M.I.Chem.E., of Lever Bros. and Unilever, Ltd., has been lent to the Ministry of Supply and is now working as Manager of a Royal Ordnance Factory.

MR. I. V. L. FERGUSSON and MR. O. N. T. DAVENPORT have been appointed managing director and director respectively of Evans, Sons, Lescher and Webb, Ltd.

MR. F. S. KERNICK was elected chairman and MR. JOHN CHRISTIE vice-chairman, at the annual meeting of the South Wales section of the Society of Chemical Industry.

DR. GEORGE STANLEY HASLAM, B.Sc., Ph.D., of the Amalgamated Denaby Collieries, Ltd., and MR. GEORGE WILLIAM SINCLAIR, of Cyanamid Products, Ltd., have been elected members of the Institution of Chemical Engineers.

MR. GEORGE LEAF has been awarded the Mercer Scholarship in Chemistry at the University of Manchester; Messrs. JAMES GREEN and NEVILLE MOWER divide the Woodiwis Scholarship in Chemistry at the same University.

SIR CHRISTOPHER CLAYTON has resigned from the chairmanship of the Liverpool Gas Co. He joined the United Alkali Co. just over 45 years ago as a research chemist; within 10 years he was a director, and he is now a director of Imperial Chemical Industries, Ltd.

MR. WILLIAM MANSBRIDGE, M.I.Chem.E., consulting chemist from 1903 with Messrs. Meade-King, Robinson and Co., Ltd., is being awarded the honorary degree of M.Sc. by Liverpool University. Mr. Mansbridge has had a long and distinguished career, identified with the chemistry of soap and lubricants, since he entered Price's Candle Co. as laboratory assistant in 1885. Apart from many appointments in this country, he was chemist in 1894-5 to the Goodwin Mfg. Co (glycerine and stearine manufacturers) in the U.S.A., and in 1899 was soapmaking expert with Van den Berghs in Rotterdam. He is also a noted entomologist, being an expert on the lepidoptera of Lancashire and Cheshire.

OBITUARY

MR. ERNEST ROBINSON, who died recently at the age of 61, was at one time in the employ of Messrs. J. W. Towers & Co., before leaving Widnes to establish a business as laboratory furnisher in the Manchester district.

MR. ROBERT BROOKE FLORIS, F.I.C., who died at Surbiton in June at the age of 71, was employed in the chemical department of the Metropolitan Water Board for 30 years, retiring in 1935 from the position of deputy director of water examination and chief chemist.

Mr. FREDERICK BASCOMBE, F.I.C., who died at Paignton on June 23, aged 91, trained in the school of the Pharmaceutical Society, where he obtained a medal for analytical chemistry. He was later occupied with public analyst's work and devoted himself to municipal affairs, being Mayor of Lambeth in 1925-6. He retired from active work in 1929.

MR. C. PETER SANDBERG, C.B.E., M.Inst.C.E., who died at Crockham Hill, Kent, on June 26, aged 64, was noted in the metallurgical world for his processes for increasing the wearing capacity and resistance of steel rails, including the "Sorbitic," "In Situ," and "Sandberg Oven" processes. The last is specially recognised as a practical solution of the problems of internal fissures in rails (*e.g.*, railway tracks) subject to intensive wear.

Metallurgical Section

Published the first Saturday in the month

Manganese in the United States

Largest March Imports from Brazil

UNITED STATES production of manganese ore, containing 35 per cent. or more manganese, during March, was 1800 long tons, shipments were 2000 tons, and producers' stocks at the end of the month were 2210 tons, reports the Bureau of Mines, United States Department of the Interior. In February, production was 2500 tons. The average monthly shipments in 1939 were 2442 tons; the total amounted to 29,307 tons.

General imports in March of metallurgical manganese ore (35 per cent. or more Mn) amounted to 139,063 long tons gross weight, with a manganese content of 63,799 long tons. Of these totals, Brazil supplied 49,130 (21,146) long tons; the Union of South Africa, 33,063 (15,381): and British India 21,677 (10,513).

March imports for consumption of battery-grade ore were 3742 long tons (522 tons from the Netherlands East Indies and 3220 tons from the Gold Coast), containing 2112 tons of manganese. There were no entries or withdrawals of ferruginous manganese ore in March.

The figures embodied in the above statistics are especially interesting if taken into consideration along with the position of manganese steel production in the United States during the last war. At that time the production of manganese steel was seriously interfered with by the stoppage of manganese ore supplies from Russia. Russia was then, as the Soviet Union is now, the largest producer of manganese ore in the world, the comparative figure being just over 2,000,000 tons in 1914, and just under 3,000,000 in 1941. The principal mines are situated at Tshiaturi, in Georgia, and at Nikopol, in the Ukraine, and transport is normally maintained from Black Sea ports.

Warned by the state of affairs in 1914-18, the United States have been gradually relying to a smaller and smaller extent on imports of this ore from Russia, the percentage having been reduced from 33 per cent. a few years ago to 15 per cent. last year, while this year it is approaching the vanishing point.

British Empire Sources

Naturally, other sources have been tapped to make up for the unreliability of the Russian supply. Low-grade deposits in Brazil, Chile, and Cuba have been made commercially available, thanks to capital expended largely by United States steel producers; and more important still has been the development of British Empire deposits, largely of high grade, in the Gold Coast, India, and South Africa. At the time of the last war only the Indian deposits were of any practical importance, producing, perhaps, a million tons a year; but now the total Empire production has risen to some 3,000,000 tons, only one-third of which is required by Empire steel producers, the remainder thus being available to the United States. An examination of last year's figures reveals that about 55 per cent. of the U.S. total imports of manganese ore—some 1,300,000 tons—were derived from Empire sources, and the percentage is likely to be greatly exceeded this year even though the total is likewise rising. It should be further borne in mind that United States requirements are far from being stationary, and Empire producers can safely increase their output without fear of having a surplus left on their hands.

The June edition of the Alloy Metals Review, published by HIGH SPEED STEEL ALLOYS, LTD., Widnes, Lancs., contains a number of abstracts and references, the most important being the summary of a paper by Mr. A. E. McRae Smith on "Problems in the Production of High Strength Alloy Iron Castings," delivered before the Lancashire branch of the Institute of British Foundrymen.

Metallurgical Section

July 5, 1941

Intercrystalline Cracking of Boiler Plates

A summary of a Report from the National Physical Laboratory to the Spring Meeting of the Iron and Steel Institute.

THIS Report describes work carried out by the National Physical Laboratory under the general direction of Dr. Desch, formerly Superintendent of the Metallurgy Department. Previous work at the N.P.L. and elsewhere was summarised in Part I of the paper by Dr. Desch. The principal facts discovered as a result of this earlier work have been given in the course of our leading article on p. 1. The general results of this work have been to confirm the explanation of caustic cracking originally offered by Parr and Straub, and Dr. Desch draws the following six practical conclusions.

(1) Intercrystalline cracking in steam boilers is always associated with a high alkalinity of the water. Where this is unavoidable, owing either to the originally alkaline character of the supply or to the softening process which has been applied to a naturally hard water, a method of protection which has proved of value in practice is the maintenance of a ratio of sulphate to alkali above a certain value, depending on the working pressure. No work has been done on the use of other inhibitors, such as phosphates.

(2) The steel must be in a condition of stress, the elastic limit having been exceeded either through an external constraint, as in a riveted joint which has been forcibly brought together, or by internal stress, as in a rivet or in a plate where it has been subjected to riveting pressure. Experience with concentrating pans suggests that cracking may occur, however, in unstressed steel in the presence of very strong alkali.

(3) There must be opportunities for the concentration of the solution in capillary spaces. This is the case at riveted joints. A seamless drum presents no such cavities, and caustic cracking has not been observed in such drums, unless at joints or fittings.

(4) A high temperature must be reached. This, however, depends on the composition of the solution. Cracking may occur at or near 100° C., or it may need a much higher temperature. It is to be noted that temperatures much in excess of the working temperature of the boiler may be reached in a riveted butt-strap joint exposed to the flame.

(5) Intercrystalline cracks appear to be of two kinds, one being clearly due to the penetration of hydrogen and formation of methane by its reaction with the carbide of the steel; the other leaves the carbide unchanged, the cracks being filled with black oxide.

(6) Cracks caused by corrosion-fatigue, being transcrystalline, are of a different type. They may usually be distinguished by inspection, but a microscopical investigation is conclusive.

Stress Tests in Alkaline Solutions

Part II of the N.P.L. investigations was concerned with a prolonged-stress tests on iron and steel specimens immersed in hot sodium hydroxide solutions, the work being conducted by Dr. C. H. M. Jenkins and Dr. F. Adcock. The experiments described in this part were designed to ascertain whether caustic cracking occurred as a result of stress in an accelerating medium such as sodium hydroxide solution. Specimens were contained in a thick-walled cylindrical vessel, electrically heated, with internal fittings for applying tension to specimens, thus enabling a particular stress to be applied more accurately than when using a stuffing box. The test pieces used were in the form of plain, perforated, or notched strips about 4½ in. in length, and the temperatures used were between 225° and 250° C. Steels used had the following percentual analysis :—

Carbon	0.14
Silicon	0.02
Sulphur	0.038
Phosphorus	0.040
Manganese	0.73
Copper	0.067
Molybdenum	Trace

Most of the tests were carried out with sodium hydroxide solution of known strength and maintained at a single fixed temperature. With few exceptions, the test specimens were made from one piece of used boiler plate, which was known to be susceptible to intercrystalline cracking under service conditions. Some of the fifty tests were terminated in a few hours, while others extended over periods of up to 65 days. When maintaining the temperature at 250° C. a steam pressure of approximately 300 lb./sq. in. existed over the solution.

Narrow Margin of Failure

Certain results suggested that the margin between a stress which causes rapid failure and one which can be resisted indefinitely is very narrow. Once a small crack is formed the resulting concentration of stress causes its rapid propagation and fracture of the specimen. The general conclusions reached were as follows :—

(1) The present work on specimens of normalised boiler plate involved the simultaneous action of prolonged stress and the corrosive influence of hot strong solutions of sodium hydroxide. In some experiments the stress was concentrated by notches and by drilled holes. No important attack on the crystal boundaries occurred, a fact which disagrees in some measure with the conclusions of Parr and Straub. The authors consider that some other factor, which is necessary to give rise to intercrystalline cracking, was not introduced into the experiments. For example, such a factor might be one that would permit the ready entrance of hydrogen into the steel. Attempts to introduce hydrogen into the steel by electrolytic means have not so far produced general intercrystalline breakdown. The results of these experiments have been difficult to interpret on account of the severity of the general corrosion.

(2) When specimens of normalised boiler plate were uniformly stressed at 225° C. in a solution of high-purity sodium hydroxide to which a small amount of sodium silicate had been added, a very slight amount of intercrystalline cracking took place. This attack was of a shallow type and occurred both in the highly-stressed metal of the test length and in practically unstressed metal near the end of the test-pieces. Specimens stressed appreciably beyond room-temperature yielded stress fracture in a few hours, whilst specimens stressed under similar conditions in a solution of high-purity sodium hydroxide resisted the attack for many days. Owing to the excessive influence of general surface corrosion in these strip specimens, it is doubtful to what degree these results apply to material of plate thickness.

(3) In order to study the effect of stress concentration, both perforated and notched specimens were stressed at 225° C. in a solution of commercial sodium hydroxide. In the perforated specimens, where regions of moderate stress concentration existed, deterioration of the metal was caused by the steady growth of the original non-metallic inclusions in the steel. A different effect, however, occurred in the regions of highly-localised stress in notched specimens; here the material failed owing to cracking, mainly transcrystalline, but occasionally influenced in direction by the presence of a crystal grain boundary.

(4) Heavily cold-worked boiler-plate material, uniformly stressed at 225° C., and exposed to commercial sodium hydroxide solution, resisted for long periods a stress which would have caused fracture of a normalised specimen of the same material in a few hours when tested in a similar manner.

(5) The black magnetic oxide formed on specimens of mild steel when exposed to sodium hydroxide solution at 225° C. was found by analysis to correspond closely in composition with Fe_2O_3. At higher temperatures, Fe_3O_4 was obtained.

Reaction at High Temperature

Part III: Exposure of iron and steel specimens to sodium hydroxide solution at high temperature and pressure. Experiments described under Part II showed that when boiler-plate material was immersed in sodium hydroxide solution of density 1.29 at temperatures up to 250° C. and maintained under a stress sufficient to cause definite yielding, rupture occurred in a few hours. This confirmed the work of Parr and Straub. On the other hand, inspection of many test-pieces subjected to combined stress and caustic attack failed to reveal intercrystalline cracks. The complex nature of the reaction persuaded the N.P.L. to study the reaction between iron and steel and sodium hydroxide solution at high temperatures, this work being conducted by Dr. Adcock assisted by Mr. A. J. Cook. The best results were obtained by using a silver-lined steel tube as the pressure vessel.

The intercrystalline cracking of boiler plates in service may occur gradually, and becoming appreciable only after a considerable time. It was impossible to conduct many long-period experiments imitating such conditions with the single piece of apparatus available, but one test lasting 17 days was made at 300° C. A piece of boiler plate, previously cold-worked, was subjected to the action of sodium hydroxide solution of density 1.29. On micro-examination, after test, the polished and etched specimen was found to contain intercrystalline cracks near areas of pearlite which had in places suffered slight decarburisation. A number of experiments, lasting about 17 hours and at a temperature of 410° C., demonstrated that the same cold-worked material when in contact with this solution developed intercrystalline cracks similar to those produced at 300° C. Boiler-plate materials and mild steels behaved quite differently when fully annealed, and were found to be free from cracks after 17 hours at 410° C. in sodium hydroxide solution of 1.29 density. On the other hand, a 1.1 per cent. carbon steel and four high-purity alloys developed intercrystalline cracks, but less than the corresponding cold-worked samples.

In investigating the mechanism of cracking under these conditions a specimen of boiler plate, which had developed cracks as the result of sodium hydroxide attack in the pressure tube, was drilled to pieces under mercury in a special apparatus so that the gas evolved could be collected; this had the percentual analysis:—

Methane	72.9
Hydrogen	7.3
Nitrogen	13.8
Carbon monoxide	5.9

The gas collected amounted to ten times the volume of the specimen. In general, the chemical conditions existing inside the specimen during the caustic attack appeared to be quite different from those at the surface. Although the surfaces, after test, were coated with oxide, yet no oxide could be detected in the cracks that had formed in the interior.

The mechanism of cracking appeared to be as follows: Hydrogen was produced near the surface and diffused into the metal, where, in some circumstances, it attacked the carbide particles. This reaction produced methane, which was unable to diffuse out of the metal and formed the intercrystalline cavities, which contained the gas under high pressure. The oxidising attack was confined to the surface, and in this region the carbide particles were more resistant than the ferrite, as was most clearly shown in a high-carbon steel. The oxide coat in its gradual advance into the metal reached some of the cavities, formed earlier by the hydrogen attack, and filled them with oxide.

Methane-Containing Cavities

High-purity iron-carbon alloys, which had been allowed to solidify in the crucible and subsequently annealed, cracked under caustic attack, but not so rapidly as the same materials when cold-worked. This suggests that the hydrogen diffusing through the ferrite can only attack the carbide when minute (sub-microscopic) cavities are available for the initial quantities of methane produced. Such cavities may exist in cast alloys and in cold-worked commercial mild steels, but not in steels which have undergone considerable hot-working and subsequent annealing. This view is supported by the behaviour of a high-purity iron-carbon alloy (carbon 0.13%). This material when hot-forged and later annealed cracked much less readily than did the metal in the as-cast and subsequently annealed state.

These experiments confirmed the belief that the cracking produced in the pressure tube by the action of sodium hydroxide was almost identical with that produced by gaseous hydrogen under high pressure. On opening the pressure tube after most experiments with caustic solution some well-formed glistening octahedral black crystals of iron oxide were found adhering to the ends of the silver plugs. These crystals were magnetic and proved to be cubic Fe_3O_4 deposited directly from the liquid. The deposition of iron oxide at a distance from the seat of formation might conceivably result in the complete sealing of a crevice in a boiler and the subsequent development of excessive pressures in the enclosed space. Longer-period tests, one of which lasted 60 days, made with mild steel specimens in contact with sodium hydroxide solution of density 1.29 revealed that destructive cracking might occur during the caustic attack on steel at quite low temperatures.

The Effect of Cold-Working

The experiments in the silver-lined pressure tube show that when fabricated steel plate was acted on, at 410° C., by sodium hydroxide solution of medium strength (35 parts of NaOH + 100 parts of H_2O, by weight), no intercrystalline cracking occurred, provided that the material was in the annealed condition. On the other hand, the corresponding cold-worked material developed, throughout most of the sample, intercrystalline cracking of a somewhat discontinous type associated with the carbon-bearing areas and probably identical with that produced by high-pressure hydrogen at high temperatures. This type of cracking was also produced in 17 days at 300° C. Although the cracking at 410° C., and to a lesser extent at 300° C., was associated with the decarburisation of the pearlitic areas, this effect was often absent in the early stages of the attack. The combined pressure of hydrogen and steam often rose to 3 tons/sq. in. in the silver-lined tube towards the end of an experiment at 410° C., and it is possible that the difference in behaviour between annealed and cold-worked material may hold strictly only for these particular experimental conditions.

It is safe to assume, however, that cold-working the steel increases its susceptibility to the hydrogen type of intercrystalline cracking.

With caustic solutions of much higher concentration, intercrystalline attack of another type was produced in steel specimens treated at 410° C. These cracks tended to form a more continuous network penetrating the metal from the outer oxide coat. In the early stages, however, the cracks often stopped short at the carbon-bearing regions. These

cracks were usually filled with oxide (termed for convenience cracks of the oxidising type), and differed from the hydrogen type of cracking, as they penetrated annealed or cold-worked steel, as far as could be judged, with equal facility. Again, cracks of the hydrogen type were often found throughout the whole mass of a cold-worked specimen, while those of the oxidising type existed in patches always in communication with the outer coat. Both types of cracking may be present in a steel sample, where cracks will be seen not only alongside pearlitic areas, but also in regions where the carbon-bearing constituent is absent. The effect on the mechanical properties of such a dual attack would be very serious.

It was not possible to make long-period experiments with strong caustic solutions in the silver-lined pressure vessel at temperatures below 410° C., but the experiments made at 350° C., 275° C., and 150° C. in the sealed steel tubes showed how destructive cracking might occur at these temperatures. Although these tubes originally contained the weaker caustic solution (density 1.29), a gradual concentration occurred, owing to the formation of iron oxide and the escape by diffusion of hydrogen. Finally, this investigation, although incomplete, has shown that the reaction between steel and sodium hydroxide solution at elevated temperatures is complex. At least two distinct modes of intercrystalline cracking were detected under laboratory tests, and it is probable that both forms contribute to the caustic cracking of boiler plates under service conditions.

Part IV: "Strain-Etch Markings in Boiler-Plate Material of Acid Open-Hearth Manufacture," by Dr. Adcock and Dr. Jenkins, was of purely metallurgical interest and showed that well-defined strain-etch markings are produced only in material which has undergone deformation at elevated temperatures. Repeated bending is unnecessary, as a single bend will enable strain-etch markings to be produced.

Grooving and Fissuring

Part V: "Some Experiments on the Behaviour of Specimens of Boiler Plate and Boiler Joints Subjected to Slow Cycles of Repeated Bending Stresses while Immersed in a Boiling Aqueous Solution," by Dr. Gough and Mr. Pollard, was suggested by the fact that boiler failure is not always characterised by the intercrystalline type of cracking, but marked grooving and fissuring have been encountered in many boilers. These defects are usually found at sharply curved portions or other places where local stress concentrations exist. Cases of this kind which have been examined at the N.P.L. exhibit no evidence of preferential attack along grain boundaries of the type which suggests a general breakdown between the crystal grains. Owing to "breathing" or "letting-down" of the boiler, such regions will be submitted to cyclic stressing in the presence of a corrosive agent, which supplies the conditions requisite for the type of accelerated failure generally described as corrosion-fatigue, which, usually much more destructive in its action than the ordinary form of fatigue, generally produces a fracture of the same essentially transcrystalline type, often accompanied, however, by such fissures or grooves at the surface of the fracture or crack. It is, therefore, possible that corrosion-fatigue failure may be a factor in some instances of boiler failure.

It was considered rather unlikely, in view of previous experience, that corrosion-fatigue conditions would result in a definitely intercrystalline type of failure; studies of the behaviour of specimens exposed to simultaneous static stress and corrosion indicated that these would more probably achieve this result. A suitable machine was designed and constructed, capable of applying repeated loading, varying from nearly zero to a maximum of 10 tons, at an operating frequency of 35 cycles per min. The specimens, which may consist of one, two, or three samples, according to size, were stressed as simply supported beams of which the middle half was subjected to cycles of a uniform bending moment. The specimen under test was so arranged that it could be tested either in air or totally immersed in a boiling aqueous solution of sodium hydroxide in distilled water to produce corrosion-fatigue conditions. All the tests reported have been made under the latter conditions and were made on material taken from one cast of Siemens-Martin open-hearth acid mild steel, conforming to a specification for boiler material of good quality. The specimens fall into three classes: (a) 3-in.-wide strips of plate, $\frac{5}{8}$ in. and also $\frac{3}{4}$ in. in thickness; (b) 12-in.-wide riveted points made of $\frac{5}{8}$-in. plate and fitted with double-riveted double cover straps; and (c) 3-in.-wide strips of electrically-welded butt joint. The initial strength of the sodium hydroxide solution was 6000 grains per gal.; this high degree of concentration was chosen as probably comparable with that occurring locally in service after evaporation has taken place, permitting a high concentration within joints, etc.

Conclusions

The principal fact that emerges from the results of the investigations is that, under the test conditions employed, samples of boiler plate, riveted joints, and welded joints failed by a process which is essentially that associated with corrosion-fatigue; the predominantly intercrystalline type of cracking ascribed to failure by caustic embrittlement was not produced. Considerable evidence is available, from certain service boilers, that corrosion-fatigue is a possible cause of danger, and similar fissuring and cracking of this type was reproduced in the present tests. In these tests, the applied ranges of stress which were found necessary to produce fracture were relatively so high—in comparison with nominal working stress adopted in practice—that little cause for alarm would arise from the actual results, although it should be remembered that the test conditions of temperature were much lower than those prevailing in modern practice; also the maximum period occupied by any one test was small in comparison with normal boiler life. It is therefore possible that under service conditions much more rapid attack might result, and hence every effort should be made in operation to exclude, as far as possible, conditions which would be conducive to such attack. It is of interest to find that, even with the somewhat artificial conditions used in the tests, one example was encountered of the occurrence of cracking in a riveted joint at a position in the interior of the joint and near a rivet; such cracks have been found in service failures, the crack being of transcrystalline character as in the present tests.

Australian Aluminium

Manufacture from Native Bauxite

REPORTS from Canberra last week record the Australian Government's decision, voiced by Senator McBride, Minister of Supply, Development, and Munitions, to manufacture ingot aluminium from bauxite, of which there are large deposits in New South Wales, Queensland, and Victoria that can be economically worked. The initial cost of the plant and equipment is £A1,500,000, apart from the provision of electric power, of which more than 20,000 h.p. is required annually for smelting. Rolling mills are already available, and an extrusion plant is being installed at the works at Sydney of the Australian Aluminium Company to make alloys with magnesium—which will be produced in Australia before the end of the year—and with other metals. A factory for the manufacture of alumina from bauxite is also to be built.

Dr. J. J. C. Bradfield, of Sydney Harbour Bridge fame, is quoted as claiming to possess the first aluminium made in Australia from native raw material. He further stated that he would soon be producing it in commercial quantities at the plant of Queensland Electric Steel, Ltd. Samples of Queensland bauxite, from Tamborine, showed that 4 tons of ore would make 1 ton of alumina, or ½ ton of aluminium. Electricity charges, at present rates, would be over £A55 per ton of aluminium fabricated, representing about 24,000 kWh per ton.

Explosions from Metallic Dusts

Hazards Demanding Further Investigations

FROM 1917 to 1939, in the United States alone, there were at least 45 explosions due to aluminium, magnesium, or zinc in powder form in which the losses of life and property were serious enough to warrant a report in newspapers or trade publications. An analysis of these disasters shows that 44 lives were lost, 58 other persons were injured, and damage to property exceeded $1,700,000, say, £340,000. The hazard was not confined to the United States; it was present in all other countries where metallic powders are manufactured or handled. Increasing use of such materials in industry has emphasised the need of investigating this hazard more closely, and to this end the United States Bureau of Mines has made a preliminary report of previous work done on the subject, which has been published as Information Circular 7148.

Aluminium Powder

Aluminium powder, more commonly known as "aluminium bronze," is used widely in the manufacture of metallic paint, in printing, in the preparation of aluminium-coated paper, as an ingredient of flashlight powder, for the protection of balloon fabric, in welding, and to a small extent for decorative effect in the manufacture of articles of plastic origin. Its ignition temperature, as determined by different investigators, shows variation. In two cases it is given as between 480° and 490° C., but in extreme fineness as low as 230° C. One report states that clouds of aluminium dust could be ignited by the sparks produced when steel was held in contact with a grinding wheel. Explosive limits, as reported, also vary widely; in two cases the lower limit of concentration was between 40 and 50 mg./litre, and in another case as high as 430 mg./litre, although for the latter figure it is doubtful whether all the dust was in perfect suspension. Another investigator has reported the ignition of aluminium dust at concentrations as low as 7 mg./litre with a glower or electric arc as source of ignition, and at 14 mg./litre when the induction spark was used.

In all reports there is mention of increases in pressure as the concentration is increased, but with considerable variation when the particle size of the material differs. Within the range used by most of the investigators the pressure rise was almost directly proportional to the concentration when similar dust was used. One investigator states that the maximum pressure increases and the time required to reach the maximum decreases as the size of the particle is decreased; for particles of size 1.3, 0.6, and 0.3 μ, the pressures were 7.7, 8.6, and 10.6 atmospheres, and the time was 0.06, 0.03 and 0.012 seconds respectively, with a concentration of 0.7 gm./litre. Attention is also called to the fact that about 300 mg. of aluminium powder will consume all the oxygen in one litre of air at room temperature and pressure.

Among the peculiarities already noted by investigators there is particular interest in the statement that aluminium foil or powder can be ignited not only by spark or fire, but also by the effect of light. Flash lamps containing aluminium foil and oxygen have been found to ignite the aluminium foil in similar bulbs at a distance of 10 to 20 cm. with an interposed screen of moistened cellophane. Several investigators state that the inflammability of finely divided aluminium depends on the amount of surface exposed. Another investigator calls attention to the increased risk of explosion when oxygen carriers are present; ordinarily stable under friction, aluminium powder explodes violently with gentle rubbing after the addition of potassium chlorate.

Magnesium powder is used chiefly in flashlight mixtures, flares, star shells, tracer bullets, and for the production of smoke screens. It all such uses it may be mixed with aluminium or some other metallic powder. As with aluminium powder, various ignition temperatures are reported by different investigators. Although no tests appear to have been made on the ignition temperatures of magnesium and aluminium dust clouds for similar conditions, a comparison of the available data indicates that fine magnesium powders may be ignited at temperatures below those required to ignite the finer sizes of aluminium powder. Regarding explosive limits, it is stated that pressures of one atmosphere were produced at concentrations of 50 mg./litre, or 50 oz./1000 cu. ft. of air. This would indicate that the lower limit is well below the limit determined for aluminium powder.

Extraordinarily high pressure can develop in explosions of magnesium powder or even with the dust from magnesium alloys. In one series of tests there was developed a pressure of 68 lb./sq. in., or nearly double the pressure from aluminium or corn starch under similar conditions; experiments made with corn starch showed higher figures than for other carbonaceous dusts. As to the peculiarities noted, it may be mentioned that sparks from a grinding wheel can ignite magnesium dust, and one explosion is on record where three men were killed and several others injured.

More than 11,000 tons of zinc powder, usually called "zinc dust," were produced in the United States in 1938, the greater part of which passed to metallurgical plant for the recovery of gold and silver from cyanide solutions, or was used as a reducing agent in dyestuff manufacture. Smaller amounts of zinc powder have been used as an ingredient of smoke-screen compositions.

Zinc Dust Hazards

Zinc dust, owing to its weight, does not readily form a cloud in suspension in air. Ignitions have been reported at concentrations of 100 and 500 mg./litre, when pressures of 3 and 8 lb./sq. in. respectively were produced. Improved methods of testing have resulted in obtaining pressures of 23 lb./sq. in. from zinc powder containing 92 per cent. metallic zinc. Manufacturers make special effort to keep the powder dry, and warn users of the danger of contact with moisture. Water oxidises zinc dust at ordinary temperatures, with liberation of hydrogen; one investigator reports that enough heat may be produced to ignite the hydrogen or any zinc dust near at hand.

An accurate estimate of the extent of the explosion hazard in connection with the manufacture of aluminium, magnesium, or zinc powder is difficult to obtain, on account of the fact that the producing plant is usually operated as part of an establishment engaged in the manufacture of other metal products; in some cases the powders can be regarded as by-products. Nevertheless, it is evident that small fires occur much more frequently than is generally supposed. Since any fire in the presence of these metallic dusts is potentially the beginning of serious explosion, and laboratory tests have demonstrated the ease with which these dusts can be ignited, it can be concluded that risk of explosion exists wherever aluminium, magnesium, or zinc powder is manufactured or handled. Although relatively few works may be producing the powders, the hazard exists in some hundreds of other works owing to the extending use of such powders in industry, and the present record of explosion losses clearly indicates the necessity of developing protective measures to guard against the ignition of metallic dusts.

The report of a recent disastrous fire involving a 15-ton heap of magnesium filings near London, shows that the fire lasted for nearly 24 hours and that 14 men of the fire brigade were seriously injured by explosions that occurred while they were endeavouring to protect adjacent sheds containing stocks of aluminium and magnesium turnings, iron filings, and magnesium dust.

At present no safe and satisfactory method can be recommended for extinguishing a large fire involving aluminium,

magnesium, or zinc powder. Water causes oxidation and the release of hydrogen; streams of water from hose-pipes may throw dust into suspension and so form explosive mixtures of dust and air; atmospheres of inert gas may retard ignition, but are ineffective in extinguishing a fire which has obtained a good start. Violent explosions of magnesium powder have occurred in atmospheres in which the oxygen has been reduced to as little as 12 per cent. Small fires, it is true, can be extinguished by use of sand or rock dust, in some cases by forming a ring or barrier round the burning powder so that the fire may be allowed to burn itself out without spreading. Great care, however, must be taken to avoid disturbing the burning powder when applying sand, or other suggested material for similar purpose, in view of the explosion danger.

Protection against the hazard of explosion at works where these metallic powders are being made or used is largely a matter of fire prevention. Cleanliness is of the utmost importance: no dust must be permitted to accumulate where it might be thrown into suspension in air and so form an explosive mixture. The metallic powders must be kept dry in order to prevent heating and possible ignition. All equipment must be earthed to prevent the accumulation of charges of static electricity. Precautions must also be taken to prevent the production of electric sparks, likewise sparks developed by the striking of steel or from grinding wheels. Magnetic separators should be installed to remove tramp iron and other material which might produce sparks in mills or polishers. Non-sparking tools should be used for repair work wherever there is presence of metallic powders; likewise the use of naked flames must be prohibited. To reduce the hazard still further, it is recommended that powder-making sections of a works be segregated from other buildings, and that they be of one storey only, with a roof of the lightest possible construction so that it will lift readily in case of an explosion.

Magnesium Production

The Present and the Future

ESTIMATES in the American Press forecast this year's magnesium requirements in the United States to be somewhere in the region of 100,000 tons. This huge figure is partly due to the substitution of magnesium alloys for aluminium alloys in constructional work; but by no means a negligible part of the new demand is for incendiary raw material.

Magnesium production has, it is well known, increased phenomenally during the last few years. Between 1937 and 1940 the total world figure rose by 125 per cent., from 19,800 metric tons to 45,000. Recent developments suggest that this year at least 60,000 tons are likely to be made available by new production. It is significant to note that the U.S. production is rapidly overhauling the German. In 1937 Germany, with 12,080 tons, produced 60 per cent. of the world total; and in 1940 the German figure of 20,000 tons still accounted for 40 per cent. of the total. But this year the United States is almost certain to attain the highest production figure among magnesium-producing countries.

Some idea of the rapid rise in American production can be derived from the following figures, collected by the U.S. Bureau of Mines. In 1938 American production only just exceeded 2000 tons, and even last year only one company, the Dow Chemical Co., produced magnesium in the United States, but its output had expanded to 6250 tons. This year the Dow Chemical Co. (which has more than doubled its capacity within the past twelve months) expects to produce 15,000 tons, while another 15,000 tons are expected to be supplied by five new works in the United States, three of which have been financed by public funds. As raw material supplies are virtually unlimited (most of the new works employ sea water as raw material) further large-scale expansion in the United States appears certain after the end of this year. Great Britain is the third largest magnesium producer, with an output in 1939 of exactly 5000 tons. No later figures are, of course, available, though it is known that production has been greatly expanded.

While the enormous expansion in world magnesium output has been stimulated by war requirements, which absorb almost all the current supply, this branch of the light-metal industry should not meet great difficulties in finding adequate outlets for its increased production after this war. Hand in hand with the increasing output the price of the metal has been reduced, and the present United States price of 27c. per lb. is about 45 per cent. cheaper than the average in 1930. Moreover, continuous progress has been made in casting, forging, and heat treatment of magnesium and its alloys, and the present increased use of the metal is certain to lead to further progress in this direction. The exceptionally light weight and great strength of magnesium, especially in its alloys, make its use attractive for many purposes in peace industries, especially in the field of transport of all kinds.

Aluminium Salts

Record Year's Shipments in the U.S.A.

ALUMINIUM salts shipped in the United States in 1940 exceeded those in the previous peak year of 1939 by 4 per cent. in quantity and 9 per cent. in value, according to the Bureau of Mines, United States Department of the Interior. Producers reported the shipment of 513,520 short tons, valued at $12,882,578, compared with 494,032 tons, valued at $11,813,299, in 1939. Shipments of aluminium sulphate, the principal product of the aluminium salts industry, totalled 463,799 tons in 1940 compared with 443,029 in 1939, an increase of 5 per cent. Sales of aluminium chloride advanced 22 per cent. over those in the previous year, while shipments of alumina, excluding that used by the aluminium industry, increased 9 per cent. in quantity and 26 per cent. in value over 1939.

Manufacturers reported the consumption of approximately 189,000 long tons of dried bauxite, 8047 short tons of alumina, 2076 tons of aluminium metal, and a quantity of clay, alunite, beryl, and chromite residue. It should be noted that of the alumina shipped in 1940, about 31 per cent. was used in the manufacture of aluminium salts, chiefly iron-free aluminium sulphate, aluminium chloride, and sodium aluminate. About 61 per cent. of the bauxite used by the chemical industry was of domestic origin; the remainder was imported.

Imports of aluminium salts during 1940 amounted to only 21 short tons compared with 828 tons in 1939. Exports of aluminium sulphate aggregated 43,615 tons, valued at $994,861, an increase of 26 per cent. in quantity and 34 per cent. in value over the 34,734 tons, valued at $744,755, exported in 1939. The increase in export trade is attributed to the war, for Europe hitherto supplied a substantial part of the South American aluminium sulphate market, which greatly increased its purchases from the United States in 1940. On April 15 aluminium salts were placed under export control. Other aluminium compounds exported in 1940 totalled 1920 tons compared with 1792 tons in 1939. Alumina imports totalled 12 tons compared with 1 ton in the previous year; exports were 20 tons, as against 106 tons.

THERE WAS A DECREASE OF 5.3 per cent., from 616,424,138 yen to 583,454,984 yen in the imports of ores and metals into Japan during the period January-September, 1940, compared with the corresponding period in 1939. This was due to increased local demands in several of the supplying countries. No information of any kind is available about the classes of ores and metals imported nor of the sources of supply.

IMPORTS OF MICA from India into the United States during the third quarter of 1940 were valued at $290,321 compared with $224,293 in the same period of 1939. Imports of chrome ores were 9203 tons as against 10,418 in 1939; and the imports of titanium ores 32,484,310 lb. compared with 54,501,440 lb. The respective figures for shellac were 8,943,094 lb. and 6,973,195 lb.

An Improved Pickling Process*

Use of Tin Salts in the Bath

AN interesting use of the electro-chemical properties of tin is made in the electrolytic pickling process of the Bullard-Dunn Company, which was developed at their plant at Bridgeport, Connecticut (U.S.P. 1,898,765 and 1,917,022), and is now in use in England.

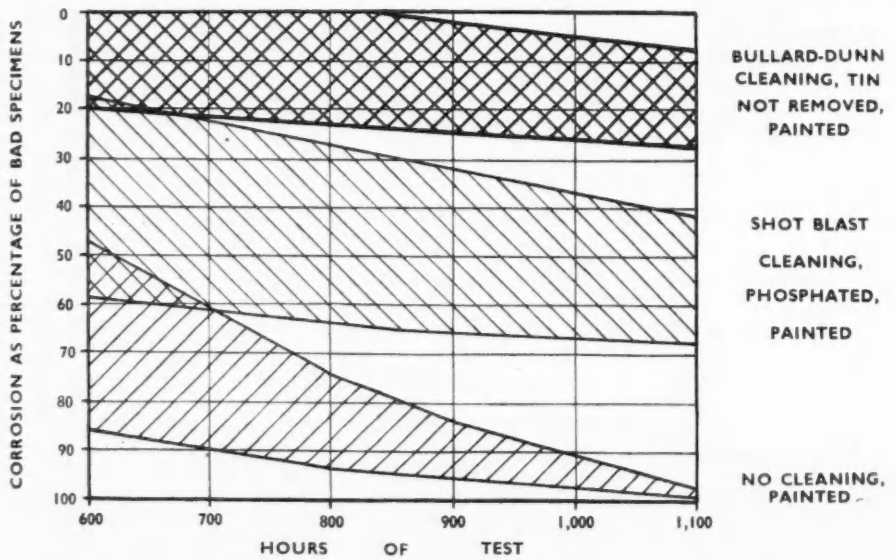
Unlike the ordinary acid pickling solutions used for steel, the Bullard-Dunn bath does not cause etching, pitting, or permanent embrittlement, and a further advantage is that recessed areas of the work are descaled as completely as the more exposed surfaces. These valuable features are explained by the presence of a small quantity of tin salts in the pickling liquor. As soon as any point on the steel surface is cleared of scale a film of tin is deposited on it and, although extremely thin, this film protects the metal from further acid attack, prevents direct solution of the iron in the acid, and eliminates pitting. The film of tin is sufficient protection to prevent steel surfaces from rusting during periods of storage in the course of manufacture and has proved a very effective preparation for surfaces to be painted; indeed, both the adherence of the paint and the corrosion resistance of the steelwork are improved. Prospective users may naturally expect that the process will increase the cost of pickling because of the tin consumption; in fact, however, the tin consumption is exceedingly small and the silicon iron anodes used prolong the life of the solution by as much as four or five times that of an ordinary immersion pickling bath.

The iron or steel article to be descaled is made the cathode in a hot dilute solution of sulphuric acid containing about 1 gm./litre of tin sulphate. The current density used is of the order of 60 to 80 amps. per sq. ft., which causes copious evolution of hydrogen at the surface of the work and thereby assists the acid in removing the scale. The tin ion concentration is so small that no tin is plated on scale, but as soon as scale is removed from the surface a protective film of tin is deposited and there is no further attack by the acid at that point. This forces the acid to concentrate its attack elsewhere and greatly accelerates the pickling process.

The tin content of the bath is maintained by having a small percentage of the anodes of pure tin, but the majority of the anodes are of a high silicon iron. It is found that these anodes acquire a thin porous film of silica behind which the oxygen is released and eventually discharged without passing through the body of the solution. This inhibits the formation of ferric salts. It has been found that a concentration of about 3 oz. of ferric salts per gallon slows down pickling and causes pitting, and that the special anodes used are an important factor in the economy of the process.

An American manufacturer made an interesting series of tests in a search for an improved method of protecting his output of steel window frames against corrosion. The material was rolled steel section weighing about 1¼ lb. per foot which, ordinarily, was assembled in the "as rolled" condition and then painted. The steel was covered with mill scale, some of which was closely adherent and some of which flaked off easily. Rusting occurred quite rapidly, sometimes even during the storage of the raw bars.

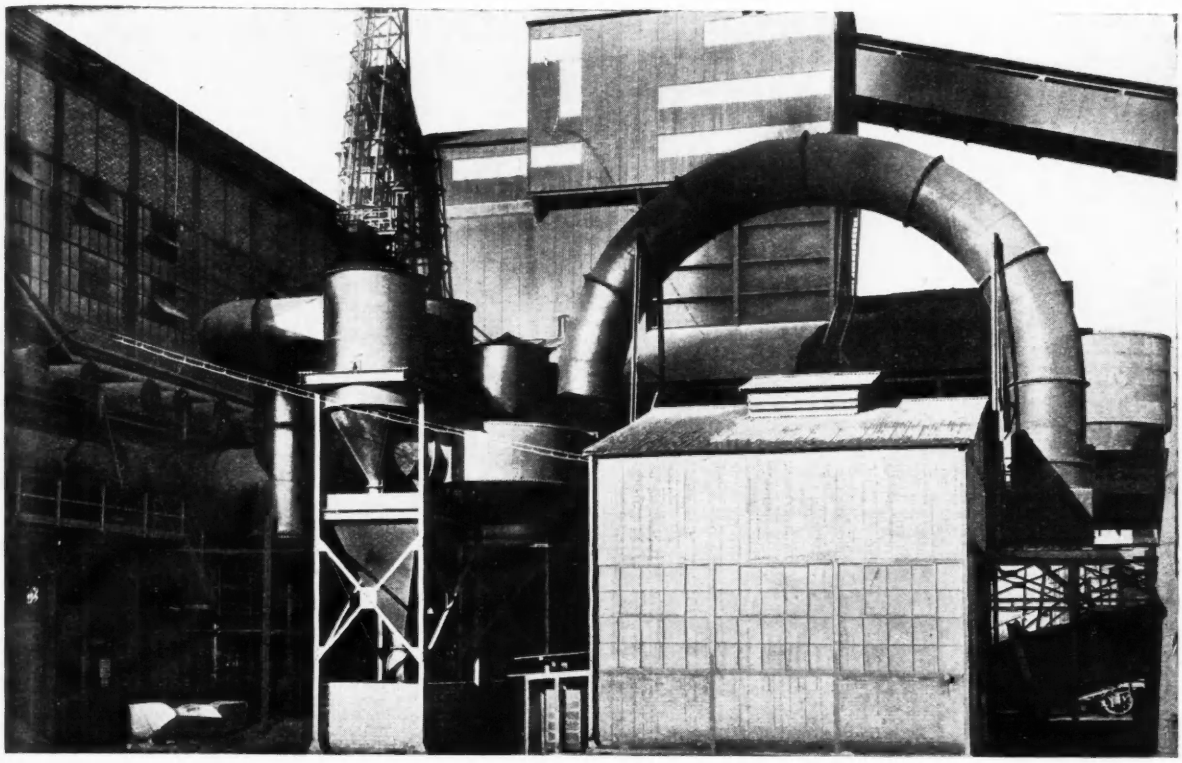
The Bullard-Dunn cleaning process was one of many tested, and the general procedure was to carry out accelerated corrosion tests on 5 in. lengths of the standard section and to check the results against actual atmosphere exposure tests. Several paints were used, each paint being tested over all types of cleaning and pre-treatment, and every precaution was taken to ensure that the paint films were of equal thickness. Charts were prepared of these tests, the results being plotted irrespective of whether the tests were accelerated or atmospheric exposure. The ordinates measure corrosion in terms of the percentage of bad specimens and the abscissa scales of time have been drawn so that the atmospheric tests fit the scale used for the accelerated tests.



Comparative corrosion after painting preceded by different methods of cleaning. Shaded areas show normal range of variation

The chart shows that specimens cleaned by the Bullard-Dunn process with the tin deposit not removed were, on the average, affected about a quarter as much as the completely uncleaned specimens and about half as much as the shot-blasted phosphate-coated specimens. This very satisfactory performance appears to depend on obtaining a thoroughly clean surface without disturbing its chemical or physical structure, and this the Bullard-Dunn process accomplishes to an unusual degree.

* From an article by Dr. J. Kronsbein, of the Electro-Chemical Engineering Co., Ltd., in the May, 1941, issue of *Tin and its Uses*.



HOWDEN INDUCED DRAUGHT AND DUST-COLLECTORS WORKING IN CONJUNCTION WITH SINTERING PLANT

JAMES HOWDEN & CO. (LAND) LTD

CAXTON HOUSE, LONDON, S.W.1

HOWDEN

General News

THE PRESENT ADDRESS of Wilfrid Smith, Ltd., chemical manufacturers, is 107 Fenchurch Street, London, E.C.3.

THE NEW SYNTHETIC VITAMIN B1 PLANT of Roche Products, Ltd., of Welwyn Garden City, Herts., is now in full production; it is the largest plant for the manufacture of aneurin in the world.

THE TREASURY HAS MADE AN ORDER, entitled the Safeguarding of Industries (Exemption) No. 3 Order, 1941 (S.R. & O. 1941, No. 899) renewing until December 31 the exemption from Key Industry Duty of all articles at present exempt.

H. F. ROBINSON AND CO., chemical manufacturers, Culcheth Chemical Works, Culcheth Lane, Newton Heath, Manchester, 10, are among the list of new members of the Manchester Chamber of Commerce, elected at the Board meeting held on June 9.

TO ENCOURAGE FARMERS and agricultural merchants to book orders for sulphate of ammonia at an early date, the Government will provide for a special distribution allowance of 28s. 1d. a ton on orders of more than 2 cwt. during July up to the limit of the quantity earmarked for the allowance.

A FOLDER ENTITLED "POISON GAS" has been compiled by Mr. A. E. Johnson and published by John Bale Medical Publications, Ltd., price 2d. It contains concise notes on the detection of gas, its effects, treatment, decontamination, etc., and may be conveniently carried in a gas mask case.

THE MINISTRY OF SUPPLY has issued the Control of Fertilisers (Nos. 10, 11 and 12) Orders, 1941; The Control of Fertilisers (No. 10) Order revokes No. 7 Order, 1940; No. 11 Order revokes Nos. 1 and 2 Orders, 1939; and No. 12 Order revokes No. 9 Order, 1941.

THE MINISTRY OF FOOD announces that there will be no change, with one exception, in the existing prices of oils and fats allocated to primary wholesalers and large trade users for the five weeks ending August 2. The exception is that the price of mixed soft acid oils is raised by £1 per ton to £19 per ton naked, ex store.

THE MINISTRY OF SUPPLY Iron and Steel Control has been taking a census of steel stocks this week on the lines of the one held at the end of 1940, which yielded valuable results in formulating Government policy on supplies of steel. Some 30,000 firms are being asked to complete and return forms by July 7, but not makers of finished steel, structural engineers, or stockholding merchants, who are already making regular stock returns.

Foreign News

VITAMIN B1 (thiamin hydrochloride) has been added to the list of chemicals made in Canada, as from June 5 for the purpose of the administration of Tariff Item 208t.

THE EXPORT OF CREAM OF TARTAR, argol, and wine lees from the Union of South Africa is prohibited except under permit from the Minister of Commerce and Industries.

THE AMERICAN POTASH INSTITUTE has moved its main offices to the American Chemical Society Building, 1155 Sixteenth Street, Washington, D.C.

EXPORTS OF CLOVE OIL from Zanzibar in 1940 rose to 388,296 lb. from 367,536 lb. in 1939. The figure reached is the highest since clove-oil distillation was started in 1936.

CHILEAN IMPORTS OF CALCIUM CARBIDE increased from 12,382 quintals in 1939 to 30,355 in 1940, of which total the United States supplied 27,550 quintals.

THE LATEST REPORT of the Committee of the Indian Chemical Manufacturers' Association shows that membership has increased and its representative character has been recognised by the Government of India.

THE RECOVERY OF LIGHT OILS has recently been made obligatory upon gas companies in Switzerland. The War Industries and Labour Office has also ordered that light oils, suitable for the manufacture of pure benzol, toluol, and xylol, must now be reserved to meet the requirements of Swiss industries.

THE SERRANA S.A. OF BRAZIL are reported to be endeavouring to revise their two-year Government contract for working the apatite mines. They agreed to produce a minimum of 6000 tons of phosphate products annually; the actual production is greatly below this owing, say the company, to insufficient market development.

From Week to Week

SULPHUR PRODUCTION at the works of the Sulphur Quarries, Ltd., Gaza, Palestine, amounted to 1400 metric tons in 1940, compared with 800 in 1939. Imports of sulphur into Palestine in 1940 amounted to 719 metric tons and exports were 1045 tons.

ANHYDROUS SODIUM MOLYBDATE, Na_2MoO_4, is now being manufactured on a commercial scale in the United States. The Climax Molybdenum Co., New York, are offering the product, with a purity of 90-95 per cent., at the price of 47 cents per lb.

THE OFFICES OF *Industrial and Engineering Chemistry* and the *News Edition*, both published by the American Chemical Society, have been moved from 706 Mills Building to 1155 Sixteenth Street, N.W., Washington, D.C.

SEARCH FOR PICKLING INHIBITORS in Germany, to lower acid consumption and avoid metal loss, has revealed that dibenzyl sulphoxide is a potent synthetic inhibitor in very small concentration. Quinoline is moderately potent, and starch offers a cheap though not highly potent alternative.

UNITED STATES exports of calcium carbide reached 17,700,000 lb., valued at $649,000, in the first quarter of 1941; nearly half this amount went out in March. Shipments for the whole of 1940 amounted to 32,000,000 lb., valued at $1,300,000. Large amounts have been shipped to England and Argentina.

THE CEYLON STATE COUNCIL has approved the expenditure of a sum not exceeding 225,000 rupees for the erection and equipment of a "pilot" plant capable of manufacturing up to 100 tons annually of acetic acid. Normally, Ceylon imports acetic acid from continental Europe, but recently has had to look to the United States as the principal source of supply.

IMPORTS OF CREOSOTE OIL into the United States, amounted to 5,324,000 gallons during the first quarter of 1941—a marked decline from the 12,300,000 gallons received during the corresponding months of 1940. The total imports in 1940 amounted to 39,000,000 gallons, compared with 51,900,000 in 1939. The United Kingdom and Japan together supplied 97 per cent. of this, the former 33,000,000 and the latter 5,000,000 gallons.

IT IS STATED IN WASHINGTON, says Reuter, that within a few days the Defence Plant Corporation will announce a $60,000,000 synthetic rubber development programme, to produce 80,000 tons annually (during 1940 only 2375 tons were produced by private plants); half in new plants to be erected and managed by the Government and the remainder in subsidised plants.

THE SPANISH SOAP INDUSTRY has been seriously effected by a continued lack of raw materials. Owing to the Government's unwillingness to release olive oil to the soap factories, and the shortage of copra and caustic soda, it is claimed that the industry has been prevented from producing sufficient quantities of soap to overcome the serious shortage existing in many parts of the country. The distribution of laundry soap is rationed by the Government, and in certain parts of Madrid no soap has been made available under this system for some time.

Forthcoming Events

THE 60TH ANNUAL GENERAL MEETING of the Society of Chemical Industry will be held in the Lecture Hall of the Royal Institution, Albemarle Street, London, W., on July 8, at 2.30 p.m., and if it be necessary to adjourn, it will be continued in the Lecture Room of the Chemical Society at Burlington House, London, at 4 p.m., on August 8. The usual business meeting will be followed by the President's Address, and by tea at the invitation of the president. At about 4.30 to 4.45 p.m. the Society's medal will be presented to Sir Robert Pickard, who will then deliver his address. Before the meeting an informal lunch will be taken at Stewart's Restaurant, 50 Old Bond Street. Attendance is limited to 80, including ladies. Accommodation will be booked in rotation and it will not be possible to seat anyone who has not notified the General Secretary before July 6—address, Clifton House, Euston Road, London, N.W.1.

THE ELECTRODEPOSITORS' TECHNICAL SOCIETY are holding a meeting at Northampton Polytechnic, St John Street, E.C.1, on July 14, at 7.15 p.m., when a discussion will take place on "Plating Problems in Relation to the War Effort." The president, Dr. H. J. T. Ellingham, will take the chair.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—**The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.**)

GITTINGS AND HILLS, LTD., Birmingham, paint and varnish manufacturers. (M., 5/7/41.) June 16, mortgage to Midland Bank, Ltd., securing all moneys due or to become due to the Bank; charged on Tower Varnish Works, Salford Street, Nechells, Birmingham, with fixtures, etc. *Nil. Dec. 31, 1940.

STOCAL ENAMELS, LTD., Birmingham. (M., 5/7/41.) May 21, charge to Barclays Bank, Ltd., securing all moneys due or to become due to the Bank, charged on contract moneys. *Nil. April 15, 1940.

Satisfaction

HAREFIELD LIME CO., LTD., Rickmansworth. (M.S., 5/7/41.) Satisfaction June 6. £3,000, registered Feb. 15, 1940.

Company News

J. Ferrer, Ltd., have increased their nominal capital beyond the registered capital of £200 by the addition of £800 in £1 shares.

Cerebos, Ltd., announce a net profit for the year of £244,890 (£323,377).

British Plaster Board, Ltd., announce a profit for the year to March 31 of £471,004 (£467,201), and have declared an ordinary dividend of 15 per cent. (30 per cent.).

Peter Brotherhood, Ltd., have declared a final dividend of 12 per cent. on the ordinary shares, making a total of 20 per cent. (same).

Wm. Butler and Co. (Bristol), Ltd., tar distillers, have declared a profit of £34,994 (£40,048), and announce a dividend of 7 per cent. (10 per cent.).

Caribonum Trust, Ltd. which holds the entire issued capital of **Caribonum, Ltd.,** has declared an interim ordinary dividend of 3 per cent.

Titanine, Ltd., have declared a final dividend of 10 per cent., making 20 per cent. for the year to March 31 (22½ per cent.). Profits, after tax, were £22,550 (£32,263).

Newcastle-upon-Tyne Zinc Oxide Co., Ltd., have increased their nominal capital beyond the registered capital of £50,000, by the addition of £10,000 in £1 ordinary shares.

Reckitt and Colman, Ltd., announce a profit for the year of £1,891,288 (£1,917,540), and have declared a final dividend of 5 per cent., making 20 per cent. (same).

British Glues and Chemicals, Ltd., announce a dividend of 10 per cent. on the ordinary stock and 1 per cent. participation on the 8 per cent. cumulative participating preference stock for the year ended April 30 (same).

Lovering China Clays, Ltd., announce a profit for the year to March 31 of £13,864 (£18,168). After provision for taxes, debenture interest, etc., this results in a net loss of £2568 (net profit £3015).

The directors of the **Metal Box Co., Ltd.,** state that the completion and audit of the accounts have been unavoidably delayed, but should be available in about one month. An interim dividend of 5 per cent. (same) has already been paid for the year to March 31.

British Alkaloids, Ltd. (manufacturers of T.C.P.) record a net profit of £51,767, as against £66,758 last year. The main reason for the decline is the increase in the allowance for E.P.T., which rose from £18,500 to £24,578. £22,002 (£23,367) has been written off the balance of advertising expenditure; the appropriation to general reserve is £1000 (£2500), but taxation reserve is £18,300 (£17,500). The carry-forward is £3469 (£5663).

New Companies Registered

Thylene Co., Ltd. (367,792).—Private company. Capital, £100 in 100 shares of £1 each. To acquire (1) the business of manufacturer of and dealer in lubricants, oils and greases carried on by Kenneth Aske, at Waterside, Halifax, and (2) the business of manufacturers of and dealers in soaps, disinfectants, cleansing preparations, industrial solvents, oils, fats and chemicals carried on by Wm. E. Aske, at 26 Savile Park, Halifax, as the "Thylene Co." Subscribers: Kenneth W. Howarth, C.A.; Roy Radford. Solicitors: Longbotham, Horsfield and Fielding, 8 Harrison Road, Halifax.

Chilva Laboratories, Ltd. (367,801).—Private company. Capital, £200 in 200 shares of £1 each. Manufacturing chemists, manufacturers of and dealers in fertilisers, sheep dips, insecticides, paints, polishes, lacquers and cleansing materials, etc. Subscribers: Eva Hudson; Fred S. Hudson, 954 Leeds Road, Dewsbury.

Malt, Oil and Minerals, Ltd. (367,808).—Private company. Capital, £100 in 100 shares of £1 each. Disinfectant manufacturers, manufacturing chemists, oil refiners, and manufacturers of artificial manures and fertilisers, etc. Subscribers: George H. Fowler; Wm. Dale. Harold A. Best is one of the first directors. Registered office: Coronation Works, Victoria Street, Grimsby.

Carvansons, Ltd. (367,771).—Private company. Capital, £500 in 500 shares of £1 each. Manufacturers of and dealers in chemical compounds and preparations, essential oil distillers, manufacturing chemists, drysalters, distillers, manufacturers of and dealers in soaps, paints, pigments, dyestuffs, etc. Directors are: Frank Carter; Wm. C. Evans. Registered office: 323 Broad Street, Pendleton, Salford.

Chemical and Allied Stocks and Shares

FIRM and slightly more active conditions have ruled on the Stock Exchange, where sentiment reflected the further rise in British Funds and more hopeful views as to the latest phase of the war. Where changed, the majority of industrial securities have moved to slightly higher prices, although there was only moderate improvement in demand. In fact, absence of selling was once again an important factor influencing markets, and the prevailing belief is that demand will continue to centre on gilt-edged and other stocks of the fixed interest-bearing class.

The majority of shares of chemical and kindred companies made better prices in accordance with the general trend in the stock and share markets. Imperial Chemical, for instance, were 31s. 9d., compared with 31s. 4½d. a week ago, and, allowing for the deduction of the usual half-yearly dividend from the price, the 7 per cent. preference units at 33s. 3d. were little changed on balance. Lever and Unilever made the better price of 23s., while slightly higher prices ruled for the company's various classes of preference shares. The units of the Distillers' Co., although "ex" the final dividend, which keeps the total distribution at 16¼ per cent., were quite well maintained at 65s. 6d., and the preliminary statement for the past year's working created a good impression in the market. On the other hand, British Plaster Board 5s. shares were inclined to be reactionary, and have moved back to 14s. 9d., a rather higher dividend than 15 per cent. having been expected in some quarters of the market. Nevertheless, bearing in mind all factors, including the weight of taxation, the results must be regarded as an excellent achievement. British Oxygen remained firm at 66s. 6d., and British Aluminium were 6d. higher at 43s., while Borax Consolidated made the slightly better price of 28s. 6d. Turner and Newall were firm at 70s., and Metal Box shares made the higher price of 75s. awaiting the financial results.

Elsewhere, Associated Cement were firm at 53s. 9d.; the interim dividend is due to be announced next month, and general expectations are that it is likely to be kept at 5 per cent. Nairn and Greenwich, whose interim is also impending, were higher at 55s.; Barry and Staines improved from 27s. to 28s. Following publication of the full results showing higher trading profits, Cerebos were quoted at £7⅞. There was again a better trend in iron, steel and kindred shares, including Staveley ordinary, which were 47s. 6d., and Guest Keen, which were 24s. Results of the two last-named companies are expected to be issued this month. Among other results, which may be issued this month or in the early part of August, are those of Greeff-Chemicals Holdings, whose 5s. units are quoted at 5s. 7½d. In other directions, Fison Packard were close on 32s. and B. Laporte close on 60s., while Cooper McDougall £1 ordinary shares were again quoted at par, and Monsanto Chemicals 5½ per cent. preference at 22s. 6d.

Pending the full results for the past year's working, Boots Drug 5s. ordinary had a firmer appearance at 34s. Elsewhere, British Drug were 22s. 6d., and Beecham's Pills 2s. 6d. deferred were quoted at the rather high price of 8s. 4½d. There was again a better tendency in General Refractories shares, which were firm at 8s. 1½d., on market hopes that improvement in the company's earnings may be continuing. At 9s. 9d. Imperial Smelting were unchanged, as were Amalgamated Metal at 18s., and British Match at 33s. 6d. British Oil and Cake Mills preferred ordinary were easier at 40s. 6d. Aided by the full results of Bleachers and hopes that the forthcoming results of Calico Printers may also show improvement, textile securities were better. Courtaulds were steadier, the prevailing view being that the interim dividend is likely to be maintained. Allied Ironfounders shares were firm at 17s., on the improved profits for the past year, and the higher dividend of 6 per cent. British Industrial Plastics have transferred at 2s 9d.

There was not much activity in Anglo-Iranian, Burmah Oil and other oil shares, but in most instances prices were slightly higher on balance for the week.

APPOINTMENT VACANT

STAFFORDSHIRE COUNTY COUNCIL.

The County Council invite applications for the post of

ASSISTANT CHEMIST

for the County Laboratory at Stafford, commencing salary £300 per annum.

Candidates must have the qualification of the Institute of Chemistry, and must have had experience in the work of a Public Analyst's Laboratory.

The appointment will be subject to the provisions of the Local Government Superannuation Acts, 1937 and 1939 and to one calendar month's notice on either side. The successful candidate will be required to undergo a medical examination and to produce his birth certificate.

Forms of Application may be obtained from the undersigned, and must be returned together with copies of three recent testimonials on or before Monday, 21st July, 1941.

H. L. UNDERWOOD,
Clerk of the County Council.

County Buildings,
Stafford.
1st July, 1941.

EDUCATIONAL

Great Possibilities for
QUALIFIED CHEMICAL ENGINEERS
Key Men in Wartime and Afterwards.

Many of the finest posts in Britain in Wartime are reserved for Chemical Engineers. The same will be the case when the war is over. The vast technique and experience now being applied to Chemical Technology for war purposes will then be suitably utilised in reconstruction, and in trade and commerce.

Enrol with the T.I.G.B. for the A.M.I.Chem.E. Examinations in which home-study Students of The T.I.G.B. in the last two successive years have gained :—

TWO FIRST PLACES. TWO "MACNAB" PRIZES.

Write to-day for "The Engineer's Guide to Success"—free, containing the world's widest choice of Engineering Courses—over 200—the Department of Chemical Technology including Chemical Engineering Processes, Plant Construction, Works Design and Operation, and Organisation and Management—and which alone gives the Regulations for A.M.I.Chem.E., A.M.I.Mech.E., A.M.I.E.E. C. & G. B.Sc., etc.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN,
219, Temple Bar House, London, E.C.4.

FOR SALE

'Phone 98 Staines.

JOHNSON Filter Press, 24 Chambers, 15 in. square; C.I. Jacketed Tipping Mixing Pan, 30 gallons; Oil Cooler or Condenser, 6 ft. by 2 ft. Brass Tubes; 3 Speed Electric Bowl Mixer, 80 quarts.

HARRY H. GARDAM & CO., LTD., STAINES.

CAST IRON POWDER for Sale,
30, 60 and 90 mesh to suit customer's requirements.
George Cohen, Sons & Co., Ltd.,
Broadway Chambers, Hammersmith,
London, W.6. (Riverside 4141).

THREE-MIRACLE GRINDERS No. 3 size Fan delivery Cyclone Collectors and Direct coupled 45 h.p. Slip Ring Motors and Oil Immersed Starter to each for 415V. 3P. 50C. (Two) Booth Beater Grinders and Dressers Combined side dressing screens for Super Fine Grinding (Two) Blackstone 30 in. and 24 in. Dia. High Speed Stone Mills. Rapid Automatic Packer. No. 3½ Disintegrator. Burnell Sifter and Mixer combined. Centrifugal Sifters, etc. Edward Booth, Booth Street Mill, Congleton. (Grams : Edward Booth, Congleton).

600

TORRANCE "LITTLE GIANT" Change Pan Mixer, with pan 16 in. dia. by 10 in. deep, machine-cut gears, fast and loose pulley drive, complete with spare pan.

Royles Calorifier, cast iron casing, 1 ft. 2 in. dia. by 4 ft. 6 in. long, arranged with Royles Patent Copper tubes, complete with automatic valve.

Copper Steam Jacketed Tilting Pan, 18 in. dia. by 17 in. deep, mounted on cast iron stand, fitted with tilting handle.

Copper Steam Jacketed Tilting Pan, 24 in. dia. by 23 in. deep, mounted on bronze trunnions, carried in cast iron cradle.

No. O size Harrison Carter Disintegrator, running at 5000 r.p.m. requires 4 h.p. to drive, arranged with belt pulley and feed hopper.

No. 2½ Christy & Norris Disintegrator, latest type, with automatic worm feed, ring oil bearings, 1250 r.p.m. and requires 18 h.p. to drive.

Size L59 Disintegrator by Harrison Carter, with beater chamber 9 in. dia. mounted on cast iron stand, running at 5500 r.p.m. and requires 3 h.p. to drive, fitted belt pulley.

Timber Lead Lined Tank, 6 ft. 0 in. long by 2 ft. 6 in. wide by 3 ft. 3 in. deep, 2 in. thickness timber, stayed with mild steel bars.

Steam Jacketed Cast Iron Boiling Pan, 2 ft. 0 in. dia. by 2 ft. 7 in. deep, mounted on three cast iron legs and bottom run-off.

"STANLOCK" System Vertical Steam Air Heater, 5 ft. 2 in. high by 1 ft. 7 in. dia. arranged 1 in. bore wrought iron steam pipes, complete with 5 h.p. motor driven Fan, 400-v. 3 ph. 50-cy. supply.

GEORGE COHEN
Sons & Co., Ltd.,
STANNINGLEY, LEEDS.

"JOHNSON" jacketed 90 lb. per square inch Filter Press, with 30, 42 in. plates and frames 2 in. thick; 36 in. underdriven Hydro Extractor, with 5 h.p. 200/400-volt Century Motor; 200-gall. stainless steel jacketed Retarder; "Premier" 10 in. Colloidal Mill; "Gaulin" 3-piston Homogeniser; "Pearns" horizontal Vacuum Pump, cylinders 6 in. dia. by 6 in. stroke; "Worthington" ditto, cylinder 8 in. dia. by 12 in. stroke; Disintegrator No. 5, beater chamber 68 in. dia. Dartnall Bros., 248 Humberstone Road, Plaistow, London, E.13.